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APPLICATION OF SHEAR WAVE ELASTOGRAPHY IN SUPERFICIAL LYMPHNODES WITH HISTOPATHOLOGICAL CORRELATION.

Radiology

KEYWORDS: Lymph nodes (Ln), malignancy, shear wave elastography (SWE), ultrasonography, and needle core biopsy.

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ABSTRACT

Ultrasound (US) is inexpensive, widely available, and accepted modality for evaluating superficial lymph nodes (Ln). Due to the overlapping features in appearances between normal lymph nodes, reactive lymph nodes, lymphomas and metastases in gray scale imaging histopathology work up under ultrasound guidance is necessary to make a definitive diagnosis. However, new technology elastography have extended the opportunity for the differentiation of malignant from benign lymph nodes. The Shear Wave elastography (SWE) is an US-based technique that works on the basis of the shear wave propagation speed, thereby producing a real-time elastogram with quantitative elastic information (in Kilopascals). Promising results were seen in some superficial organs such as breast and thyroid using SWE [1-3]. Till today, only few studies are available demonstrating the usefulness of SWE in lymph nodes [4-6]. The purpose of the current study is to assess patterns of Shear Wave elastography with histological status of lymph nodes in clinical routine practice.

INTRODUCTION

Cervical lymph nodes (Ln) assessment is essential in patients with head and neck pathologies because it helps in selection of treatment options. B-mode ultrasound (US) imaging is routinely used for preoperative imaging and confirming diagnosis. The presence of cystic content, spherical shape, central vascularity and calcification determine sonographic features of malignancy where as presence of fatty hilum suggests a benign lymph node.

Lymphatic spread of papillary thyroid carcinoma (PTC) most frequently seen at the cervical Lymph node. Recent studies revealed that metastasis to regional Lymph node predict least survival rates.

Mechanical properties of tissues/superficial organs can be evaluated by applying an external force and monitoring the deformation response with strain and shear wave elastography. Relatively low displacement of tissue is linked to decreased elasticity and malignancy. As this technology has been integrated into conventional US machines, shear wave can quantify velocity and thus indirectly measure tissue stiffness [7]. However, the use of US-based new technology has extended the opportunities for the differentiation of malignant from benign lymph nodes. The Shear Wave elastography (SWE) is an US-based technique that provides both qualitative colour coded real time elastogram and also quantitative maps either of elasticity(in Kpa) or of shear wave velocity(in cm/sec). SWE showed promising results in some superficial organs such as breast, thyroid.To date, the usefulness of SWE in lymph nodes has been studied in only few studies.

AIMS AND OBJECTIVES:

The aim of the current study is to correlate findings of shear Wave elastography and b-mode ultrasound with histopathological status of lymph nodes in clinical routine practice.

MATERIALS AND METHODS:

We prospectively evaluated 100 consecutive patients (60 women, 40 men) from feb 2015 to aug 2016 using Aixplorer (SuperSonic imagine®), who approached for needle core biopsy under ultrasound guidance of lymph nodes were included in this study. One target lymph node per patient was biopsied. Histology was obtained for all lesions. All patients were evaluated clinically and with sonography. We selected Lymphnode based on US features suspicious for malignancy.

Inclusion criteria:
i. Age more than 18yrs
ii. Enlarged cervical Ln more than 5mm(short axis)
iii. Thyroid nodule under treatment where Ln were found during US exam before biopsy.
iv. History of thyroid carcinoma when enlarged Ln was diagnosed during routine post-operative US exam.

Exclusion criteria:
i. Uncooperative patients.
ii.Patients with post operative complications.

Conventional USG:

Patients were examined with a superficial 10 MHz US probe. Each biopsied target to be analyzed on B mode and color Doppler according to morphological criteria as described below:

a) Presence or absence of a hilum.
b) The short-long axis ratio (S/L).
c) Shape of the target: oval or round.
d) The vascular distribution: central type, peripheral.

At the time of examination, lymph nodes are categorized as suspicious, of markedly hypoechoic, loss of hilum, hypervascularization based on the morphological criteria if (atleast two out of four) mentioned above were present.

SHEAR WAVE ELASTOGRAPHY:

Technique: SWE is performed with a thick layer of US gel applied between the probe (superficial 10 MHz) and the skin. It is to ensure that no intense pressure was applied by the operator's hand on the skin.

Manually region Of Interest (ROI) was selected to include the maximum of the B mode hypoechoic part of the target. Precautionary measures should be taken while ROI is placed, to be away from borders and to avoid possible artifacts with increased stiffness due to transducer placement or pressure.

Real time SW elastogram is displayed in as a color-scale (SWE map). Blue is coded for soft tissue, red for stiff tissues. A stiff area around the target (rim of tissue) on the SWE color map (pixels colored in yellow to red) was noted.

After selecting a ROI, SWE measurements (in Kilopascals) were acquired and following parameters were provided by the system are as follows:

I. E Mean = the mean of the stiffness values of the pixels over the ROI
II. E Max= the maximum elasticity value over the ROI

III. SD= the standard deviation of the elasticity values over the ROI. This entity is related to the homogeneity of the SWE.

For each target lymphnode, three successive SWE measurements were acquired at the time of sonography by the radiologist. Finally for each target the average of the mean elasticity value, the maximum elasticity value and the standard deviation (E mean, Emax & SD) were calculated.

Needle core biopsy:
After explaining the procedure and obtaining the consent biopsy is performed with aseptic precautions under ultrasound guidance to confirm needle placement (25gauge needle).

STATISTICAL METHODS:
Descriptive statistical tests like chi square, fishers exact test, unpaired 't' tests, were used .Results were obtained using Microsoft excel and SPSS version 17.

RESULTS:
Current prospective study of 100 patients, 95 were fulfilling the inclusion criteria. Five patients were excluded due to previously mentioned criteria. The results of enrolled patients in this study are discussed below. There were a total of 40 noncancerous Ln and 55 cancerous Ln.

Table 1: CANCER STATUS VS SHAPE

	cancer status		Total	P Value
	no cancer	cancer		
Oval	30	0	30	<0.05*
Round	10	55	65	
Total	40	55	95	

Fisher's exact test

There is a significant association between cancer status and the shape. Round shape is more commonly seen in cancer patients when compared to benign condition.

Table 2: CANCER STATUS VS PRESENCE OF HILUM

		cancer status		total	p value
		no cancer	cancer		
echogenic hilum:	absent	14	46	60	<0.05*
	present	26	9	35	
total		40	55	95	

χ^2 =23.542

There is a significant association between cancer status and the presence of hilum. Echogenic hilum is less commonly seen in cancer patients when compared to benign condition.

Table 3:CANCER STATUS VS VASCULARITY

	type	cancer status		Total	P Value
		no cancer	cancer		
vascularity:	central	40	0	40	<0.05*
	mixed	0	20	20	
	peripheral	0	35	35	
	Total	40	55	95	

χ^2 =95.00

Vascularity, especially mixed and peripheral is more associated with cancer patients when compared to benign condition which is statistically significant.

Table 4: CANCER STATUS VS COLOUR

		cancer status		Total	P Value
		no cancer	cancer		
Red	No	40	0	40	<0.05*
	Yes	0	55	55	
Total		40	55	95	

- Fisher's exact test

While using shear wave Elastography procedure for predicting malignancy a qualitative technique based on colour is used, Majority of patients who had malignancy showed red colour which is statistically significant. Appearance of red color is due to stiffness of tissue.

Table 5:CANCER STATUS VS COLOUR

		cancer status		total	p value
		no cancer	cancer		
blue	no	0	55	55	<0.05*
	yes	40	0	40	
total		40	55	95	

- Fisher's exact test

Similarly using shear wave Elastography procedure for predicting malignancy, majority of patients who had malignancy showed less proportion of blue color when compared to nonmalignant, which is statistically significant. Appearance of blue color is due to softness of the tissue.

Table 6: AREA UNDER THE CURVE

Test Result Variable(s)	Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95%	
				Lower Bound	Upper Bound
E min(K pa)	1.000	.000	.000	1.000	1.000
E mean(K pa)	1.000	.000	.000	1.000	1.000
Emax(K pa)	1.000	.000	.000	1.000	1.000
a. Under the nonparametric assumption b. Null hypothesis: true area = 0.5					

To know the diagnostic ability ROC curves were constructed for all the three variables. i.e, E min, E mean and Emax all variables showed an excellent predictive capability, with AUC equal to 1.

Emean >28.2kpa, the sensitivity is 72 % with specificity of 90%.
E max > 22.8 kpa, the sensitivity is 94 % with specificity of 96%.

TABLE 7:

k pa	cancer status	n	mean	std. deviation	std. error mean
E min(k pa)	no cancer	40	4.83	.813	.129
	cancer	55	10.22	3.241	.437
E mean(k pa)	no cancer	40	8.05	.783	.124
	cancer	55	25.36	3.734	.503
E max(k pa)	no cancer	40	11.65	.921	.146
	cancer	55	19.0	7.395	1.402

Table 8:

t-test for Equality of Means							
K pa	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
E min (K pa)	-10.277	93	.000	-5.393	.525	-6.435	-4.351
Emean (Kpa)	-28.832	93	.000	-17.314	.601	-18.506	-16.121
Emax (K pa)	-18.485	93	.000	-30.514	1.651	-33.792	-27.236

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The E min .Emean and E max values differ significantly between the Cancer and non-cancer groups which are statistically significant.

A well performed Shear wave Elastography procedure is a good noninvasive diagnostic procedure for predicting malignancies.

DISCUSSION:

The purpose of the current study is to correlate findings of shear Wave elastography as an adjunct to b mode imaging with histological status of lymph nodes in clinical routine practice.

In our present study which included 100 patients who were approached for needle core biopsy under image (US) guidance and were also evaluated clinically and with sonography. Target lymphnode was selected based on suspicious features of malignancy in b-mode imaging.

In our study there is a significant association between cancer status and shape (round shape is more commonly seen in cancer patients).

In our study there is a significant association between cancer status and the presence of hilum. Echogenic hilum is less commonly seen in cancer patients when compared to benign condition.

Rubaltelli et al. and Solbiati et al. in their study concluded that presence of echogenic / fatty hilum is predictive of benignity [8,9].

We also found Vascularity, especially mixed and peripheral is more associated with cancer patients when compared to benign condition which is statistically significant.

Ahuja et al; Dragoni et al; Na et al; Steinkamp et al. in their study reported the association of peripheral and central vascularity with cancerous lymphnode [10-13].

In our study, benign lesions were predominantly blue in color where as malignant lesions are red in color.

The elasticity of cancerous tissue is high when compared to noncancerous state, for which Emean >28.2kpa, the sensitivity is 72 % with specificity of 90%. E max > 22.8 kpa, the sensitivity is 94 % with specificity of 96%.

Bhatia et al. in their study concluded that the cutoff of mean EM> 30.2 kpa and the sensitivity, specificity being 41.9% &100 % respectively [6].

Choi et al. in their study concluded that the cutoff of max EM >19.4 kpa and the sensitivity, specificity being 91% & 97% respectively [5].

CONCLUSION:

Shear wave elastography had shown promising results when used as an adjunct to b-mode ultrasound examination in assessing lymphnodes status.

We conclude that the stiffness of cancerous lymphnodes are significantly higher and helps in distinguishing cancerous and noncancerous lesions. Thus application of shear wave ultrasound can reduce the unnecessary biopsies in distinguishing the benign and malignant superficial lymphnodes.

FIGURES:

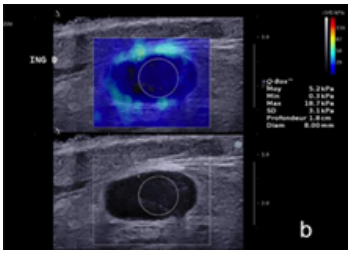

Fig 1

Fig 1 shows SWE elastograms and B mode ultrasound of inguinal lymph nodes. B mode showed same hypoechoic pattern of the lymph nodes with loss of hilum. The corresponding SWE maps showed that the hypoechoic part of the Lns was blue with corresponding Emean values of 5.2 Kpa .

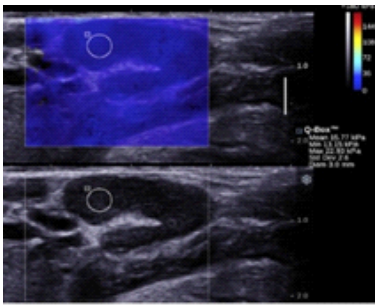

Fig 2

Fig 2: shows SWE elastograms and B mode ultrasound of cervical lymphnodes (benign lymphnode). B mode showed hypoechoic pattern of lymphnodes with echogenic hilum.

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